

GEOGRAPHICAL DISTRIBUTION OF THE WINTERACEAE

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IN THE preceding article in this Journal, Bailey and Nast (1) have summarized their conclusions concerning the comparative morphology of the Winteraceae and have commented upon the phylogenetic significance of the group. In view of the probable importance of this family in future considerations of primitive dicotyledons, a discussion of the implications of its geographical distribution seems to be desirable. The present paper is therefore complementary to the series of Bailey and Nast (see bibliography of the preceding article) and to the writer's taxonomic discussion of the family (28, 29, 30).

HISTORICAL SKETCH

The first known representative of the group of plants now known as the Winteraceae came to the attention of Europeans more than 350 years ago. In 1578 William Winter, who captained one of the ships on Drake's voyage, was forced by adverse weather to spend some weeks in the Straits of Magellan, and during this period his men learned of the antiscorbutic properties of the bark of a common Magellanic tree. This bark was brought to the attention of medical men and apparently was first described, under the name of "Winteranus cortex," by Dalechamps (7) in 1586. Subsequently the bark and the tree were described by such early students as Clusius (6), Bauhin (2), Parkinson (25), Jonston (20), Sloan (27), and Feuillée (17). At that time the "Winter's bark" was often confused with the bark of the West Indian *Canella alba* Murr., which apparently has somewhat similar properties.

A proper botanical description was given and a post-Linnaean binomial was first proposed for the plant in 1776. In this year J. R. & G. Forster (18) proposed the genus *Drimys*, with two species, the Magellanic *D. Winteri* and the New Zealand *D. axillaris*, both based upon the collections which they made during Cook's second voyage. In the same year Solander (19) published a description of the Magellanic species under the name *Winterana aromatica*, based upon collections by Captain Wallis and by Banks and Solander. The Forsters' name has been generally accepted for the generic and specific concepts as applied to the South American plant, and the binomial *Drimys Winteri* has appeared in innumerable botanical publications, often being accredited with an extensive geographical distribution which it does not possess. Typification of the genus *Drimys* and the use of the Forsters' binomial have already been adequately discussed (29: 10-17; 30: 154).

¹ In a recent bibliography (30: 164), I cited the title of a paper, "La distribution géographique et l'histoire des Winteraceae," which did not reach its destination in Switzerland in 1942, due to stoppage of mails. Some of the material in the unpublished paper is incorporated in the present treatment.

Long after its discovery in the far south, the genus was found at scattered points in South America and as far north as southern Mexico, while in Australia and New Zealand plants were found which were correctly referred to the general alliance of *Drimys Winteri*. For a long period *Drimys* and its relatives were placed in the family Magnoliaceae, but a separate family, the Winteraceae, was proposed by Lindley in 1836 (22). This name was accepted by such students of the group as Miers (24) and Eichler (15), but van Tieghem (31) rejected the name Winteraceae (founded upon *Wintera* Murr., a synonym of *Drimys*) and proposed to call the family the "Drimy-tacées" (apparently used in the Latin form only by Diels [11], as Drimy-taceae). The essential synonymy of the family has already been recorded (30: 120), while Bailey and Nast (1) have discussed its composition and have given cogent reasons for the exclusion of the genus *Illicium*.

The first careful examination of generic lines in the Winteraceae was made by van Tieghem (31), and we are indebted to Dandy (9) for a proper disposition of the New Zealand species. The 88 species of the family now recognized (29, 30) are distributed in six genera, as follows: *Drimys* J. R. & G. Forst., with 40 species (Mexico to Cape Horn, Australia and Tasmania, New Guinea, Amboina, Celebes, Borneo, and the Philippines); *Bubbia* v. Tiegh., with 30 species (New Guinea, Queensland, Lord Howe Island, and New Caledonia); *Belliolum* v. Tiegh., with 8 species (New Caledonia and Solomon Islands); *Pseudowintera* Dandy, with 2 species (New Zealand); *Exospermum* v. Tiegh., with 2 species (New Caledonia); and *Zygogynum* Baill., with 6 species (New Caledonia).

In view of the inadequate exploration of some parts of the range of the family, conclusions as to its distribution must be partially tentative. It is not to be anticipated, however, that the broad outlines of distribution within the family will be greatly modified by future exploration or taxonomic readjustment. In the sense that all taxonomic work is preliminary and subject to future revision, the present discussion is tentative. To delay a presentation of geographical data and to refrain from drawing certain inferences from them, because they will inevitably be modified by future studies, seems undesirable to the writer.

PROBABLE CENTER OF ORIGIN

When the dicotyledons first appear in abundance in the fossil records of the Cretaceous Period, they are fully differentiated into surviving families and often even into surviving genera. The evolution of the principal families of woody dicotyledons long antedates the Middle Cretaceous, and therefore the place of origin and the early migrations of specific families cannot be determined solely upon the basis of present ranges, nor even upon ranges indicated by records from the Tertiary and Upper Cretaceous. The solution of such problems is dependent largely upon essential evidence from much earlier geological horizons.

Nevertheless, it is possible to reach certain preliminary conclusions regarding centers of origin from the evidence supplied by surviving members of a group, especially in cases where the phylogeny can be reconstructed

with reasonable exactitude, as in the Winteraceae (Bailey and Nast, 1). That such conclusions are to be taken as established fact is not suggested; they merely provide us with a hypothesis subject to future checking when and if the fossil record becomes more complete. The possibility that a group of plants originated in an area far from its present range must be kept in mind; only the fossil record can indicate whether such an origin is likely for a given group. In the case of the Winteraceae the fossil record, as stated below, is so incomplete and undependable that it throws no light upon the center of origin or routes of migration of the family. Recourse to deductive reasoning, based upon a knowledge of modern members of the group, is necessary if one is to arrive at any conclusions, even tentative ones, regarding the past history of the family.

The chief center of diversification and morphological specialization of the Winteraceae appears to have been in Australasia. That this region was the probable center of origin of the family is indicated by the following facts: all of the six known genera occur there and only one in America; at least 84 species are known in the Old World as contrasted with only four in America; the total variability of the group is infinitely greater in the Old World than in the New; the New World species are comparatively highly evolved, as regards several characters (xylem, calyx, stamens, carpels), in comparison with various Old World groups; on the whole, the Old World species are more stable than those of America, where inter- and intra-specific variability are marked. Furthermore, many of the families of woody Ranales — possibly the majority of these families — among which the relationships of the Winteraceae are to be sought are predominantly Asiatic, some of them exclusively so.

On the strength of this evidence one seems to have ample reason to eliminate America as the probable place of origin of the family. In narrowing down the probabilities offered by the general Australasian region, however, one is upon less secure ground, and the conclusions drawn in the following paragraph are to be taken as highly speculative.

It seems probable that generic differentiation in the Winteraceae was taking place at a period when the Australian continent included or nearly included such regions as New Guinea, New Zealand, New Caledonia, and the Solomon Islands. The fact that four of the six known genera now occur in New Caledonia does not necessarily indicate this region as the center of origin of the family. Two of the genera which occur there, *Exospermum* and *Zygogynum*, exhibit trends of morphological specialization which indicate that they are derivative genera. *Belliolum*, known only from the eastern rim of the Australasian portion of the family, likewise appears comparatively specialized in most of its characters, although its stamens may conceivably be more primitive than those of *Bubbia*. *Pseudowintera* similarly appears to be comparatively highly evolved, with a type of inflorescence and wood ray which indicates long isolation from the *Bubbia*-like group which was probably its ancestor. The two remaining genera, *Bubbia* and *Drimys*, occur in considerable numbers in the high-

lands of New Guinea. Both genera likewise occur in Queensland. *Bubbia*, however, is lacking in southeastern Australia and also in the Malayan islands extending toward the Philippines. Since the morphological evidence points to *Drimys* Sect. *Tasmannia* and *Bubbia* as more primitive, on the whole, than the remaining groups of the family, it might be inferred that the region where both these genera occur and where their speciation is most active is the probable place of origin of the family. This evidence points toward the New Guinea-Queensland area; but in suggesting this as the probable place of origin of the family one is indulging in speculation which can be verified only by future researches, especially those pertaining to palaeobotany.

ROUTES OF MIGRATION

The geographical distribution of the Winteraceae shows an interesting pattern (see map, 30: 121), which is by no means unique. A similar bicentric-palaeoantarctic distribution is found in the families Eucryphiaceae, Goodeniaceae, Stylidiaceae, Corsiaceae, and Centrolepidaceae. Some of these have a more extensive range than the Winteraceae and others a more restricted range; however, they are fundamentally similar in having representatives in southern America and also in Australasia (sometimes extending into Malaysia and Polynesia).

The only genus of Winteraceae which occurs in both hemispheres is *Drimys*, but examples of this type of generic distribution among angiosperms will occur to students of the regions under consideration. In order to illustrate, one need mention only the following genera, some of which are more restricted than *Drimys* and others more extended: *Nothofagus* (Fagaceae), *Phrygilanthus* (Loranthaceae), *Lomatia* (Proteaceae), *Colobanthus* (Caryophyllaceae), *Laurelia* (Monimiaceae), *Aristotelia* (Elaeocarpaceae), *Eucryphia* (Eucryphiaceae), *Drapetes* (Thymelaeaceae), *Fuchsia* (Onagraceae), *Pseudopanax* (Araliaceae), *Azorella* (Umbelliferae), *Griselinia* (Cornaceae), *Pernettya* (Ericaceae), *Jovellana* (Scrophulariaceae), *Hebe* (Scrophulariaceae), *Selliera* (Goodeniaceae), *Luzuriaga* (Philesiaceae), *Leptocarpus* (Restionaceae), and *Gaimardia* (Centrolepidaceae).

Contrasting with the illustrations given above, one may mention numerous families which occur in both hemispheres but which apparently have the two parts of their populations connected by a northern, rather than a southern, link. A few of these families are the Magnoliaceae, Schisandraceae, Calycanthaceae, and Nyssaceae, while illustrations of palaeoarctic genera are well known to every student of North American plants (e. g., Fernald, 16). Incidentally, the fact that *Illicium* shows this pattern of distribution rather than the Antarctic pattern may be cited as still another reason to question its presence in the Winteraceae.

In order to account for the type of distribution illustrated by *Drimys* and by numerous other plants and animals, various hypotheses have been formulated and a voluminous botanical and zoological literature has accumulated. In the case of the Winteraceae, a majority of which are

montane plants, the seeds are of such a morphological type and so perishable as to rule out any possibility of dispersal by winds, birds, animals, or oceanic currents. Terrestrial continuity is essential for the migration of members of this family. Thus, three possibilities seem to merit serious consideration: (1) Matthew's thesis of northern origins and southward migrations, (2) Wegener's hypothesis of continental drift, and (3) Antarctic land connections.

Palaeobotanical advocates of Matthew's (23) hypothesis of the origin and migration of animals have argued that *Drimys* originated in the Holarctic and subsequently migrated into its present ranges in the Southern Hemisphere. Thus, Berry (3:165) states regarding the Magnoliaceae: "No family is more obviously of northern origin, none is better represented in the forest floras of Upper Cretaceous times throughout the northern lands, or better exhibits the southward extension so characteristic of many other types as the pressure of plant populations behind them and the availability of suitable land routes to the southward permitted. *Drimys*, the most primitive in its anatomy, is today found farthest from its original home. Unfortunately, the geological history of this genus is practically unknown but the fact that the species are distinct in each region, i. e., in Australia, New Caledonia, New Zealand and America, indicates that they were very ancient immigrants into those regions before the present geography had come into existence." Later (4: 38), the same author remarks: "Comparison of the geologic record with the recent distribution shows that *Magnolia* and *Liriodendron* radiated from a northern center of dispersal, and it seems most logical to assume that the increasingly southern belts for *Schizandra-Illicium*, *Talauma*, and *Drimys* represent a further continuation of the same direction of dispersal as *Magnolia* and *Liriodendron*."

The chief arguments in these quotations are evidently based upon the following premises: (1) *Drimys* is a structurally primitive genus of the Magnoliaceae, (2) it formerly had a Holarctic distribution, and (3) *Magnolia* and its close allies were derived from ancestors having a characteristically northern distribution. Each of these premises is unreliable.

In the first place, *Drimys* and its five allied genera belong in an independent family which at best is only very remotely related to the Magnoliaceae proper and which was not concerned in the evolution of *Magnolia*, *Liriodendron*, and related genera.

In the second place, there is no evidence to indicate that the Winteraceae ever were widely distributed in the Holarctic. Of the four recorded fossil species of "*Drimys*," three are from the Southern Hemisphere (Patagonia, Seymour Island, and New South Wales) and one from West Central Oregon. The four species are based upon leaf impressions. The papillate lower epidermis of *D. patagonica* Berry (4) suggests that this plant was winteraceous and allied to the surviving *D. brasiliensis* Miers. The reference of the Australian *D. levifolia* Deane (10) to the genus is entirely provisional, the identification being based on "a fragment of a leaf of thin texture, resembling *Drimys*, . . ."; at any rate, the occurrence of the genus

in the Tertiary of New South Wales, if corroborated, throws no light upon its distribution outside the modern range. Unfortunately, in the case of the geographically most significant fossil species, *D. antarctica* Dusén (13) and *D. americana* Chaney and Sanborn (5), no critical evidence is presented regarding their actual affinities. Until the stomata and cuticles or the vascular residues of such fossils are examined by modern palaeobotanical techniques, determinations of Winteraceae based solely upon superficial characters of leaf impressions must be considered unreliable. In other words, there is no conclusive evidence that *Drimys* ever occurred north of its present extensions into Mexico and the Philippines, nor conversely that it was formerly widely distributed in Antarctica. Furthermore, the occurrence of *Drimys* in the Goshen flora of Oregon, if authenticated, does not indicate that the Winteraceae are of northern rather than of southern origin, since it may be interpreted merely as extending the northern limits of the genus (during an admittedly warmer period) from Mexico to Oregon. The absence of Winteraceae in the numerous investigated Cretaceous and Tertiary floras of the Northern Hemisphere is to be anticipated, however, if the family is of extra-Holarctic origin and distribution with only subsidiary extensions north of the equator.

In the third place, although *Magnolia* and *Liriodendron* were abundantly represented in Upper Cretaceous and Tertiary floras of northern latitudes, there is no available evidence to indicate that the Magnoliaceae (sensu stricto) originated in the Holarctic or that such genera as *Talauma*, *Manglietia*, *Aromadendron*, *Elmerrillia*, etc., migrated southward into their present ranges in tropical and subtropical regions. The Magnoliaceae are morphologically relatively highly specialized both vegetatively and florally, and furthermore are a family with quite different morphological limits and generic diversity than supposed by Berry (3: 165) (e. g. Dandy, 8). They evidently are related to, but not directly derived from, the Degeneriaceae (Fiji) and Himantandraceae (Queensland and New Guinea). Nothing is known at present regarding the distribution of ancestral forms from which the three related families were derived.

Although the Wegener hypothesis of continental drift appears to be unacceptable at present to most geophysicists and geologists, at least in America, it continues to have an intriguing appeal to biologists. The ultimate acceptance or rejection of this hypothesis must rest upon geological grounds, but so many biological data have been cited to support it that it seems advisable to inquire into its application to problems of Antarctic distribution, and especially to the specific problem at hand. According to this hypothesis and its subsequent modifications, Pangaea was a single continent, eventually with two lines of rupture in the Mesozoic — between Euro-Africa and America, and between Africa and India. During the Jurassic, Australia broke away from India and Ceylon, and Antarctica from Africa, both retaining their connection with South America. Australia and Antarctica separated in the Tertiary, but Antarctica and South America did not separate until the Quaternary.

According to Du Toit's (14) modification of the Wegener hypothesis, there were two original continents, Gondwanaland and Laurasia, separated by the Tethys Sea. At the beginning of the Cretaceous, Australia was still connected, by way of Madagascar and India, with southern Asia. New Guinea and New Zealand broke away from Australia in the Tertiary; Antarctica separated from South America recently.

As far as the Antarctic distribution of plants is concerned, these two explanations have about the same bearing. Australia is supposed to have lost its connection with the Asiatic continent no later than the early Cretaceous, retaining its connection with America, via Antarctica, until the Tertiary. As a broad explanation of Antarctic distributions, this hypothesis is often quite credible. However, one is led to believe that the Australian flora should be more intimately related to that of America than to that of southeastern Asia. This should also be true of the New Guinean flora, which, according to all modifications of the Wegener hypothesis, should be more closely related to that of Australia than to that of Malaysia.

This, however, is not the case; the New Guinean flora is overwhelmingly Malaysian in its affinities, with fewer Australian elements. It would seem impossible to avoid the conclusion that Australia and southeastern Asia have been linked, via New Guinea and Malaysia, at some time since the differentiation of angiosperm genera. The connection between the floras of Australia and America is less pronounced, on the whole, than that between the floras of Australia and Malaysia.

Although the predominantly Asiatic elements in the New Guinean flora were acknowledged by such an authority on the region as Lam (21), the theory of the permanence of continents in this region was rejected by him in favor of Wegener's hypothesis. According to Lam, the Australian shelf, becoming disjoined from Antarctica and drifting northward, came into contact with the southeastern parts of Asia (the Malaysian arches) and was overrun with tropical species. This ingenious explanation might satisfy the facts if only the widespread lowland groups of plants were concerned. But the numerous groups of plants in common between the mountains of New Guinea and of Malaysia (*Drimys*, as an illustration, occurring in Borneo and the Philippines) cannot be explained as "recent adventives" which have passed from one region to the other in comparatively recent times, since the two areas have again drifted into proximity. On the contrary, many of them (including *Drimys*) are obviously relics, with limited means of dispersal and a high degree of local endemism.

In brief, the Wegener hypothesis, if it could be substantiated geologically, provides the terrestrial continuities necessary for the migration of *Drimys* from Australasia to South America via Antarctica, but it does not afford a valid explanation for the present distribution of *Drimys* and other montane plants of limited migrational ability in the Australasian-Malaysian regions.

The remaining hypothesis pertaining to bicentric-palaeoantarctic distributions assumes that the major land masses of the Southern Hemisphere

have been in essentially their present positions for a long period, at least since the differentiation of modern families of flowering plants; to explain the existence of the same genus, or of closely related genera, in the austral parts of both hemispheres, one assumes past land connections through Antarctica. The present environment of Antarctica is obviously unfavorable to the survival of angiosperms and gymnosperms, but the continent does have a known flora of about 75 mosses, six hepatics, and no fewer than 250 lichens (Skottsberg, 26). That at least parts of Antarctica supported a well-developed flora of angiosperms and conifers during the Tertiary and Cretaceous Periods, as well as a diversified fauna, is demonstrated, however, by fossils obtained by the Swedish South Polar Expedition. One need not assume an Antarctic origin for these plants, but merely that they reached Antarctica from one hemisphere or the other by a more or less continuous land route.

The existence of this flora being reasonably certain, it remains to connect Antarctica with America on the one hand and Australasia on the other. Most proponents of the "land-bridge" hypothesis do not imply that continuous unbroken connections were essential for the migrations of plants and land animals. On the contrary, fluctuating and comparatively ephemeral connections, often insular in nature, would provide adequate "bridges" for most migrations. Furthermore, these connections, as far as the woody dicotyledons are concerned, could well be pre-Cretaceous. The ultimate acceptance or rejection of any "land-bridge" hypothesis in a given region and period must rest upon geological evidence, but even when the present geological evidence is negative in nature, the possibility of past land connections is not to be absolutely ruled out. Biological distributional data can provide only suggestions for the solution of this essentially geological problem.

In the case of austral connections, however, the American-Antarctic land connection by means of the Scotia Arc seems to be beyond doubt, as indicated by geological observations in the South Orkneys and South Georgia, which agree with the folded ranges of the American continent; that this connection between the two continents was Cretaceous or early Tertiary has been substantiated by the discovery of fossil foraminifera. The mountains of Antarctica in many ways suggest the Andes of South America. (For a brief review of the geological evidence of this connection, the reader is referred to Du Rietz [12], where an extensive bibliography will be found.)

There was no such definite land connection between Antarctica and Australasia, but merely because geologists cannot point with certainty to this connection one is not justified in rejecting its probability. On the basis of plant distribution we may best hypothecate two independent and not necessarily simultaneous or complete connections between Antarctica and Australasia, one with New Zealand and one with Tasmania. The distribution of *Drimys*, for instance, points to the Tasmanian connection, for the New Zealand genus of Winteraceae, *Pseudowintera*, has no close rela-

tive in America. However, possibly the greater number of bicentric-palaeo-antarctic groups show the New Zealand rather than the Tasmanian affinity. Berry (4: 32-40) lays considerable stress upon the fact that many groups of plants cited in support of the theory of trans-Antarctic migration occur either in Australia or New Zealand, but not in both regions. This fact loses much of its significance if the two regions can be assumed to have had independent connections with Antarctica—an assumption, to be sure, which still awaits geological proof.

It is outside the scope of the present paper to discuss the numerous groups which have been cited as illustrations of trans-Antarctic migrations. Each of these groups needs detailed taxonomic and morphological investigation before even tentative conclusions as to its migratory routes can be reached. It is obvious that much of the discussion pertaining to this problem has been based upon inadequate data. Furthermore, there is no single solution to the problem, and conclusions which appear valid in one group may be entirely inapplicable to the next, even though their present distributions are superficially similar. It is also obvious that geological evidence must supply the ultimate answer to the problem. Nevertheless, the vast amount of accumulating biological evidence that distribution in certain groups took place by trans-Antarctic migrations is rapidly becoming incontrovertible.

SPECIATION

A consideration of the possible modes of speciation within a group is often a desirable complement to a discussion of geographical distribution, since migrations and speciation are frequently concomitant phenomena. It is obvious that in the Winteraceae, as pointed out by Bailey and Nast (1), there is no surviving genus which is "primitive" in all of its characters; on the contrary each genus is characterized by a combination of characters—some primitive and others advanced—in such a way as to indicate that the ancestral form possessed characters no longer found in combination.

The genus *Drimys*, since it occurs in both hemispheres, is of especial interest as illustrating intra-generic differentiation in the family. The American and the Old World representatives fall into two sharply marked sections, which could logically be re-established as independent genera, *Drimys* in America and *Tasmannia* in the Old World. Whether one thus recognizes two genera or two sections of a single genus, as we have done, seems immaterial to the present discussion. It is impossible to say that either of these sections is more primitive than the other. The Section *Tasmannia* appears closer to the hypothetical primitive condition in characters pertaining to its xylem, pollen, and carpels, while the Section *Wintera* seems to be the more primitive in its inflorescence and its hermaphrodite flowers.

It is significant that, of the six Australasian genera, only one, *Drimys*, occurs in America. In a preceding section I have mentioned the extreme improbability of the family having originated in America. If the origin of the family was in Australasian regions, as seems likely, one should perhaps

attempt to explain (1) why none of the genera except *Drimys* reached America, and (2) why the American representatives of *Drimys* are more primitive in some features than their Australasian congeners.

Whether the absence of all genera of the family except *Drimys* from America is due merely to chance dissemination of genetic factors in the migrating population or whether selective factors of the environment along the route of migration were operational must remain doubtful. At least the possibility of the operation of selective factors is suggested by the fact that *Drimys*, in its present range in New Guinea and Australia, survives a colder and less hospitable climate than any of the other existing genera. If the migrational route to America was through Antarctica, as hypothesized above, that portion of the family most resistant to the climate of high altitudes and high latitudes would have been most likely to make the successful migration; it cannot be assumed that the climate of Antarctica was ever tropical — more likely it was subtropical or temperate at best.

The fact that the Section *Wintera* combines certain primitive with other comparatively advanced characters is not necessarily a contradiction of an assumption that this is the migrating portion of the genus. It is merely necessary to assume that the separation of the genus into an eastern and a western population took place before such characters were fully stabilized. Again, it is impossible to suggest whether the segregation of genetic factors was due entirely to chance or whether certain unsuspected selective factors were involved.

A distribution map of the species and varieties of the Section *Wintera* (29: 9) shows the scattered occurrence of isolated units which is often characteristic of ancient groups. Predominantly montane in habit, *Drimys* approaches sea-level only in the southernmost part of America, whereas toward the north it often occurs near the upper limit of arboreal vegetation. It is significant that the genus occurs in the two oldest mountain masses of South America — the Organ Mountains and the Pacaraima Range — as well as in the Andes. The genus was apparently widespread in South America at a period when the two older mountain ranges had some sort of a highland connection with the Andean region.

The criteria used for specific and varietal delimitation have been discussed in my taxonomic consideration of Sect. *Wintera* (29), where the unsatisfactory nature of some of these criteria was emphasized. The entire American population of *Drimys* is still highly polymorphic, and classification within the genus in this region must be based upon trends rather than upon concrete morphological characters. In the absence of any discernible morphological barriers, it may be suspected that all the members of Sect. *Wintera* will prove to be interfertile. However, this is not the case in nature, the disjunction of the various populations being maintained by poor dispersal capacity and presumably also by the intervention of inhospitable regions. Apparently a fairly high rate of precipitation is essential for the survival of the genus, and a glance at the above-mentioned map (29: 9) will indicate that extensive regions of comparatively dry country separate some of the areas of persistence.

The present-day groups in Sect. *Wintera* were presumably polytopic in origin. The existence of a linking ancestral syngameon cannot definitely be proved, in the absence of fossil evidence, but it may be hypothecated with considerable assurance, in view of the limited dispersal ability of the genus. The causes of the disappearance of the ancestral syngameon may possibly lie in climatic changes pertaining to a narrowing or a shifting of high precipitation areas; this, however, is speculative.

It may be assumed that in the original large polymorphic population the genetic constitution of the various parts was not identical. As a result of geographical isolation of the component parts, the potential variability of these parts was necessarily reduced, and therefore the surviving groups are not genetically identical. There is no obvious indication of the operation of selective factors in the present-day environments of the various local units, and hence it seems likely that chance dissemination of genetic material throughout the original population was primarily responsible for the different morphological trends.

The possibility, at least, that polyploidy is involved in the evolution of taxonomic units in Sect. *Wintera* is indicated by Whitaker's (32) record of the chromosomes of "*Drimys Winteri*" as about 76 in number. This record, however, is insufficient to be taken as a basis for discussion.

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NEW KWANGSI PLANTS¹

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IN THIS paper, twelve new species and one new variety are described, all based on types from Kwangsi Province, China. In addition, three new combinations are made. Three of the new species were named by Dr. E. D. Merrill, in preliminary studies on the Chinese collections in the herbarium of the Arnold Arboretum. This paper is essentially a continuation of a previous article in this Journal (Jour. Arnold Arb. 24: 444-459. 1943). All specimens herein cited are deposited in the herbarium of the Arnold Arboretum.

OLACACEAE

Olex laxiflora Merrill in herb. sp. nov.

Frutex scandens, 0.5-3.5 m. altus, ramis ramulisque brunneis glabris, lenticellis linearibus vel nullis; foliis chartaceis vel subcoriaceis, breviter petiolatis, oblongo-ovatis, 12-15 cm. longis, 5-6.5 cm. latis, acuminatis, basi late rotundatis, utrinque glabris subconcoloribus, supra nitidis, subtus paullo pallidioribus, nervis lateralibus utrinsecus 12-15, latissime patentibus, utrinque distinctis, sat procul a margine arcuato-anastomosantibus, rete venularum utrinque elevato; petiolis circiter 1 cm. longis; inflorescentiis axillaribus glabris paniculatis, 3.5-4.5 cm. longis, laxifloris, bracteis brevibus, distantibus, pedicellis 3-4 mm. longis; calycibus 1.5 mm. longis, plus minusve cuspidato-truncatis, glabris, margine submembranaceis integris; petalis 5, linearibus, circiter 10 mm. longis et 1 mm. latis; staminibus 5, filamentis complanatis, gracilibus, circiter 5 mm. longis et 0.8 mm. latis, antheris ellipticis, circiter 1.8 mm. longis; ovario ovoideo, stylo ad 8 mm. longo, stigmate obscure 3-lobato, lobis ovoideis; fructibus oblongo-obovoideis, circiter 2.8 cm. longis et 1.3 cm. latis, calyce accrescente totis circumdatis.

KWANGSI: Shang-sze District, Shih Wan Tai Shan, near Iu Shan Village, *W. T. Tsang* 22231 (TYPE), May 7, 1933, 0.5-3 m. high, fairly common in dry sandy places, flowers pale yellow; same locality, Na Wai Village, *W. T. Tsang* 23863, July 11-30, 1934, a climber 10.5 ft. high, fairly common in sandy soil, in thickets, fruit red, edible.

The new species is characterized by its large leaves, which are broadly rounded at base, its lax inflorescences, and its much elongated, slightly ovoid fruits.

ANNONACEAE

Fissistigma capitatum Merrill in herb. sp. nov.

Frutex scandens, ramulis teretibus brunneo-tomentosis; foliis subcoriaceis petiolatis, oblongo-ovatis, 9-15 cm. longis, 4.5-8 cm. latis, late rotundatis, leviter emarginatis, basi rotundatis, margine leviter revolutis, supra in sicco olivaceis, leviter tomentosis vel glabrescentibus, subnitidis,

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